

Universities and innovation: the challenge for Europe

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LERU was founded in 2002 as an association of research-intensive universities sharing the values of high-quality teaching in an environment of internationally competitive research. The League is committed to: education through an awareness of the frontiers of human understanding; the creation of new knowledge through basic research, which is the ultimate source of innovation in society; the promotion of research across a broad front, which creates a unique capacity to reconfigure activities in response to new opportunities and problems. The purpose of the League is to advocate these values, to influence policy in Europe and to develop best practice through mutual exchange of experience.

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Universities and innovation: the challenge for Europe

Summary

The Challenge

- The increasingly open and competitive global economy and the shift to high value production based on information and knowledge requires a strong and rapid response from Europe if it is not to fall behind economically, with profound consequences for its social and cultural dynamism.
- Higher education and research are vital ingredients in the European response to these challenges. The quality of both must be of the highest international standard, the university system needs to be diverse to respond to the great diversity of demands upon it, and the innovation processes that exploit new knowledge and highly trained people must be efficient and effective. With notable exceptions and national variations, Europe must be judged as deficient in all three areas. These deficiencies must be remedied as a matter of urgency.
- In **quality**, the level of investment in universities is low by international standards, and funds for basic research are spread too thinly, severely disadvantaging centres of research excellence compared with our principal international competitors.
- In **diversity**, there has been excessive convergence towards a single model of the basic research-focused university, undermining the potential for some universities to take on a more powerful regionally-focused role.
- In **innovation**, there has been a relative failure to exploit the excellence of many parts of the research and educational capacity of the university system, particularly in comparison with the USA, and potentially compared to developing Asian economies.
- During the last decade, universities in Europe, particularly those that are research-intensive, have engaged more deeply with the innovation process as part of their mission, and through this have begun to define their actual and potential roles more clearly. It is now recognised that:
 - universities are important businesses in their own right, realising the highest levels of financial return on public investment, and making a significant contribution to GDP and national employment;
 - the route from discovery to patenting and licensing is not necessarily their most important contribution to innovation, but that more complex relationships involving the recruitment by industry of PhDs and researchers, exploitation of codified knowledge, joint problem-solving enterprises, and the use of the university as a public space together make a more influential contribution.
- It is vital however to see the university contribution in relation to specific modes of business transformation. We characterise and give examples of five: the creation of knowledge economy nodes; the creation of indigenous new businesses; transplantation from elsewhere; diversification into technologically-related businesses; and enhancement of existing businesses.
- It is important to stress that this diversity of transformations requires a diversity of university types, from research-intensive universities contributing at the forefront of the international research agenda, to universities that engage strongly with specific regional and local needs for manpower, skills and research.

The Response

- If universities are to be more effective in supporting and catalysing innovation in Europe, action is required under **three broad headings** that reflect the interaction between supply and demand, and which we suggest should be the headline issues for the university component of the Commission's "broad-based innovation strategy for the EU": enhancing supply of relevant university capacity; stimulating business demand; and improving university-business interactions. Our recommendations under these three headings are relevant to member states, to the European Commission and to universities.
- In **improving the quality and appropriateness of the university support for innovation**: universities must be given greater *autonomy* to permit them to act in a more flexible and dynamic fashion; they must be encouraged, through appropriate *funding* mechanisms, to diversify and play to their strengths so that they are better able to address the *diversity of roles* required of them; they must be encouraged, by defining strategic priorities and appropriate funding mechanisms, to address major *cross-disciplinary* issues and to ensure that their structures do not impede such developments; and ensure that their *leadership and governance* mechanisms are efficient in identifying and pursuing institutional priorities whilst encouraging the academic freedom that is the university's greatest strength.
- In **stimulating business demand for skills and research/knowledge**, member states, supported by the Commission, should implement processes through which the power of their *public procurement* budgets can be harnessed to create strong incentives to draw more strongly on the university skills and knowledge base as a means of stimulating high value technological growth, the rapid growth of SMEs and the university-business interaction. To maximise the power of this incentive, member states should increase the proportion of their procurement budgets allocated to R&D. Member states should also improve *tax reduction schemes* for expenditure on R&D and innovation.
- In **improving interactions between business and universities**, member states and regions should continue to explore and fund, in association with business, processes that enhance interaction between universities and business that are relevant to the operation and structure of their economies and to remove administrative obstacles that often impede them. The Commission should recognise that the structure of national and regional economies and business sectors makes this primarily a national and regional issue, and if it is to persist with initiatives such as the European Institute of Technology, it should do so in ways designed to build on existing strengths, structures and relationships rather than by replacing or sidelining them.

The changing world and the challenge for Europe

1. The increasingly open global economy poses challenges to countries and regions throughout the world about how they should respond to maximise economic benefit within this rapidly changing frame. The change is one of transition from economies based on land, labour and capital, to ones based on information and knowledge. Economic success will depend upon a twin-pronged approach that creates high levels of production of information and knowledge, and makes that information and knowledge readily available to the greatest number of individuals and enterprises capable of exploiting them¹, thereby creating the so-called “knowledge economy”. This is not a narrow economic issue, but one with profound consequences for the social and cultural health and dynamism of society.
2. European leaders recognised this imperative in their 2000 “Lisbon declaration”, which called for radical measures to make the EU “the most dynamic and competitive knowledge-based economy in the world” by 2010. That call has not been matched by action: the growth gap with North America and Asia has continued to widen, and six valuable years have been lost. The process of de-industrialisation², in which manufacturing is being re-located to relatively low wage economies in Asia and elsewhere has emphasised the need for Europe to focus on the production of high value, knowledge-based goods and services. But the phase in which Europe and other advanced economies have a competitive advantage in this regard is already passing, as countries such as China and India are increasingly delivering high skills at low cost. Visionary but effective strategies are therefore required to enhance the competitiveness of the knowledge base and to increase the efficiency with which it is exploited.

The need for education and research

3. Part of the solution to this dilemma is well-trying and proven. It is that investment in education and research always produces a social and economic return³. However, the magnitude of that return depends not only upon the level of investment, but also upon the environmental processes that exploit the consequent knowledge and skills: not only on the quality and diversity of *supply* but also on the power of *demand*. The European Union and its constituent states have performed relatively poorly on both counts:
 - a. **Higher education – the supply side.** European universities are severely underfunded for the tasks they are being required to undertake^{4,5}. The selective and competitive funding mechanisms needed to drive up quality are often inefficient, and many university systems lack the autonomy they need if institutions are to act rapidly and decisively in a competitive international environment. Although circumstances vary between countries and institutions and there are several distinguished exceptions, the overall consequence is that the performance of European universities is declining relative to its competitors: they are failing to attract the best international talents; too few rank amongst the world’s best; most aspire to a similar role so that the system as a whole has a relative lack of differentiated purpose, structure and mission; less than 25% of the working population has had tertiary education compared with 38% in the USA and 36% in Japan⁶; governance is often poor; and basic research has been increasingly failing the test at the highest levels of international competitiveness^{4,5}. Although world-leading excellence is often claimed, its achievement is in reality rare. But it is a crucial attribute of an effective modern higher education system. It is vital that stakeholders are able to recognise it, and cherish and stimulate it through competitive processes that promote and reward it.
 - b. **Innovative capacity - the demand side.** Europe in general suffers from a severe “innovation gap”.

1. Schleicher, A. 2006. *The economics of knowledge: why education is key for Europe’s success*. The Lisbon Council, policy brief.
2. Rowthorn, R. and Coutts, K. 2004. *De-industrialisation and the balance of payments in advanced economies*. UNCTAD Discussion paper No. 170.
3. Kelly, U., McLellan, D. and McNicoll, I. 2006. *The economic impact of UK higher education institutions*. A report for Universities UK. University of Strathclyde.
4. Lambert, R. and Butler, N. 2006. *The future of European universities: renaissance or decay?* Centre for European reform.
5. European Commission. 2006. *Delivering on the modernisation agenda for universities: education, research and innovation*. COM (2006) 208.
6. In China in 2001, about 2 million students graduated from higher education compared with 3 million in Europe; in the absence of change, participation in higher education in China is likely to outstrip Europe within a decade.

Notwithstanding the decline in its relative international standing, the European system of universities and research institutes still has major centres of international research excellence producing highly skilled and creative graduates. A central problem is that the mechanisms or the motivations through which business in Europe exploits that knowledge and capacity are weak compared with the USA. The vital process of innovation, which in this context we define as responding to market opportunities through organisational change and new ways of developing high value products and services, demands that we more effectively translate research excellence into commercial opportunities. The relatively weak pull on the research base exerted by business in Europe is exemplified by their persistent relatively low R&D spending, their weak contacts with universities especially in the SME sector (compared for example with the USA⁷), and their relative unwillingness to hire qualified researchers with doctoral degrees.

4. The European Commission has recognised the vital need for national governments to address these issues⁸. Responding to the relative decline in the excellence of basic research in Europe, the Commission has created an independent *European Research Council*, which we have previously argued⁹ could become, if adequately funded, a major driver of research excellence in Europe over the next decade. It has created *European Technology Platforms* which provide a business-led framework to define research and development priorities and action plans, and which may become potent means of linking the activities of market driven companies to relevant capacities in universities and research institutes. However, we continue to need more powerful incentives to enhance business demands on the research base to catalyse innovation processes. The proposed European Institute of Technology will not fulfil this role⁹.

The functions of universities

5. The actual and potential contributions of universities to innovation need to be seen against the background of their broader functions in society. Their traditional role as custodians and creators of knowledge and its

transmission to the rising generation in an ethos of scepticism, rigour, and the freedom to question established values and to disturb complacency, all remain central to their modern value. But the demands on them have greatly diversified as their importance in society has become increasingly recognised by Governments worldwide. Higher education of an increasing proportion of the rising generation is playing a role in the democratisation of society, in promoting social mobility and social justice and, in the words of Ben Okri¹⁰, “setting up students for the act of self discovery”. They play vital roles in national and international civic society, where they must “speak truth to power”. Universities often provide a major component of the national research base and educate the researchers who populate it, and from which much useful knowledge for society and the economy are derived. They contribute expertise and innovative and radical thinking. They are the principal sources of highly trained personnel and credible credentials, they stimulate entrepreneurship - and can be powerful attractors of business and investment into a region.

6. This diversity of demand and function has now become so great that no one institution can efficiently discharge them all. A diversity of demand requires a matching diversity of response. Too many universities in Europe are based on a similar basic research-inspired model, with the consequences on the one hand that research funding is spread too thinly, and often lacks both the depth and diversity that modern basic research requires, and on the other hand that there is a relative lack of differentiated purpose, structure and mission amongst them.
7. The demands made on a large modern university also impose great demands on institutional leadership and management. The strength of the university tradition is based on the relative freedom of academic staff to pursue their own research interests and to devise their own teaching programmes within an agreed disciplinary framework. This yields a bonus in creativity and novelty that a hierarchically managed organisation cannot emulate. However, it increasingly requires considerable leadership and management skill to ensure that the goals of the institution can be met and that the reallocation of financial resources to match changing priorities can be achieved without compro-

7. Cosh, A., Hughes, A. and Lester, R. 2006. *UK plc: Just how innovative are we?* Cambridge-MIT Institute.

8. League of European Research Universities (LERU). 2005. *Growth, research-intensive universities and the European Research Council*. Position paper 3.

9. League of European Research Universities (LERU). 2005. *Competitiveness, research and the concept of a European Institute of Technology*. Position paper 4.

10. Commonwealth Universities Association, Belfast 2003.

missing the individual freedom that is the university's source of creativity. In some European countries, even with good leadership, universities are unable to realise their potential for dynamism and creativity because of strong state control and micromanagement of their processes.

Universities as economic actors

8. It is important to recognise that universities are major businesses in their own right. For example, a recent study³ shows that in 2003/04, UK universities generated a total direct economic output of £45.1 billion (€ 78 billion), of which 39% of revenue came from private and international sources: a very high level of return on public investment, and a higher multiplier than in most service industries. They were a major service sector export earner attracting £3.6 billion of international revenue and generating 581,000 jobs (about 2.5% of the workforce), of which only 48% was through their own direct employment. Their greatest economic impact is in their own region. Although this is particularly true for universities with a predominantly regional focus, it is also true for the great research universities, for although these have a global reach and reputation, their greatest direct economic impact is still in their own region¹¹. Basic research itself, despite the long delays in its applications, has been estimated according to some¹², to yield an average annual rate of return on investment ranging from 28% to 50%, which represents an extraordinary economic impact.
9. Universities are or should be important contributors to national or regional economic planning, not only because they are important components of regional economies, but because they have a unique attribute: unlike most businesses, their location is necessarily fixed, and they have historically been amongst the most durable of institutions. As such, they have the capacity to be leaders and major collaborators with other regional and national agencies in planning and promoting regional economic development. For this to be effective however, they need to understand the innovation potential of their region, and to recognise their particular strengths and capacities in research and education and the relation of those strengths not only to regional innovation processes (paragraphs 15-20), but also to regional social and cultural priorities.

European universities need to define their corporate roles much more clearly in relation to the diversity of societal needs set out in paragraphs 5 and 6.

University support for innovation

10. At the highest level of generalisation, there are two principal routes whereby knowledge is transferred from a university to society. The first is through the annual wave of new bachelors, masters and doctors who move into employment and may carry with them new general concepts and approaches developed in the university setting and the intellectual and interpersonal skills to apply them. The second is through the interactions of private enterprise with the university research base, either by transmission of codified knowledge present in a particular research area or by exploitation of new knowledge developed in the university. Although the proportion of the population that have received a higher education, the level of that education, and the willingness of employers to increase the competence level of their workforce will determine the impact of the former, our principal concern is with the latter, where we need to understand the pathways most likely to yield public benefit. Those benefits are broadly in the social, cultural and economic domains, but here we concentrate on the economic impact of university activity, on the so-called innovation agenda.
11. The innovation process has evolved considerably in recent years in ways that create a greater role for universities. There is now increasing emphasis on innovation as an 'open' process where firms use both internal and external sources of ideas, in a global search for the best talents and capabilities, and deploy multiple business models to improve corporate performance¹³. This paradigm contrasts with the previously dominant 'closed' approach where firms relied on internal resources, and in particular the controlled environment of the corporate laboratory.
12. There is an implicit assumption in many of the initiatives taken by national or local governments or by individual universities, that the latter's most effective contribution to innovation is based on discoveries in university laboratories, followed by disclosure, patenting and licensing of the technology, leading to the cre-

11. Lester, R. K. 2005a. *Local Innovation Systems Project—Phase I Findings: Overview and Discussion*. MIT Industrial Performance Center, Working Paper 05-004, Massachusetts Institute of Technology, Cambridge, MA.

12. http://www.science.doe.gov/feature/HEP.htm_

13. Chesborough, H. 2003. *Open Innovation: The New Imperative for Creating and Profiting from Technology*. Boston: Harvard Business School Press.

ation of technology-based enterprises, often by the inventors themselves. Whilst there are several high-profile examples of the success of this route (e.g. Sun, Cisco, Cambridge Digital Radio, etc.), this is not the only route, nor does it account for the largest proportion of university impact on innovation. Even in the USA, only 2.5% of patents were University-derived in 2001¹¹, and only accounted for 4% of university R&D budgets in 2003¹⁴. The vast majority of university patents yield no royalty income whatsoever.

13. There is strong evidence that patenting and licensing are not the most effective pathways through which academic activity contributes to innovation^{15, 16}, but that the recruitment by business of PhD graduates and leading researchers, consultancy, scrutiny of the open literature and collaborative research are, taken together, more influential. A broader view therefore needs to be taken of the university role, as creators, transmitters and interpreters of ideas and new knowledge, as sources of human capital and as key components of social infrastructure and capital. There are at least five different types of interaction that contribute to knowledge exchange at the university-business interface^{11, 17, 18}:

- Providing suitably qualified human capital for the business sector.
- Providing continuing professional development opportunities to continually update the business skills base.
- Increasing the stock of codified knowledge (publications, patents and prototypes).
- Problem solving in relation to business needs (through contract and cooperative research, technology licensing, faculty consultation, incubation services etc.).
- Providing a public space function. This relatively neglected but distinctive feature of the role of universities comprises a wide range of mechanisms for interaction between university staff and the business community, including social interactions, specially convened meetings and conferences, establishing entrepreneurship centres, promoting personnel exchange, and creating a supportive built environment.

14. As increasingly important contributors to the innovation process, universities must also be aware of the shifts in business focus associated with the continuing evolution of the economy. The European economy is increasingly based on service industries rather than manufacturing, and although it is vital to maintain the strongest possible manufacturing base and the research contribution to it, there is a need for universities to address the needs of the service industries more explicitly. Whilst the service sector, for example financial services, is employing an increasing proportion of the best qualified graduates, and can be immensely innovative, it is currently poorly served by the formal research base, either in knowledge intensive areas such as financial services, or areas that are currently not knowledge intensive such as tourism.

A typology of business transformation involving universities

15. We argue that there are a number of fundamental, structured ways in which universities support the innovation process and are involved in business transformations in their region. The particular transformation route or routes to which a university can contribute depend upon three variables:

- regional, national or even EU level initiatives that may help to stimulate the innovation process;
- the nature of local business and the opportunities and policies in a region;
- the character of the university.

In discussing this we have used, as a basis for analysis, some of the typology of business transformation processes proposed by Lester¹¹.

14. Bouchie, A. 2005. news@nature.com

15. Cohen, W., Nelson, R. and Walsh, J. 2002. Links and impacts: the influence of public research on industrial R&D.

16. Agarwal, A. and Henderson, R. 2002. Putting patents in context. *Management Science*, 48, 44.

17. Lester, R. K. 2005b. *Universities, Innovation, and the Competitiveness of Local Economies*. MIT Industrial Performance Center, Working Paper 05-010, Massachusetts Institute of Technology, Cambridge, MA.

18. Lester, R.K. and Piore, M.J. 2004. *Innovation: The Missing Dimension*. Harvard University Press Boston, Mass.

Indigenous new business creation (Box 1)

16. This involves the creation of an industry that has little or no precursor in the region. It is based on exploitation of university-developed technologies that strike a market chord. It represents the linear model of discovery/patenting/licensing/start-up. The innovation process tends to be science-driven and entrepreneurial, with a

local university or research institute playing the role of anchor institution, and the highest impacts being achieved through PhD-level scientists and engineers who have been influenced by entrepreneurial business practice. University technology transfer is proactive and oriented towards start-ups and SMEs.

Box 1 – Examples of indigenous new industry created from university research

It involves the creation of an industry that has little or no precursor in the region based on exploitation of university-developed technologies that strike a market chord.

Wolfson Microelectronics plc

Wolfson microelectronics was spun out from a microelectronics research group in the **University of Edinburgh** that specialised in novel chip design. It has become a global leader in the supply of high performance mixed-signal chips for the digital market. The company supplies some of the biggest names in the digital consumer marketplace and its products can now be found inside many familiar items such as mobile phones, digital cameras, the iPod, MP3 players, DVD players, Hi-Fi's, set-top boxes, games consoles and all-in-one printers and scanners. Wolfson Microelectronics successfully floated on the London Stock Exchange in October 2003, and is now valued in excess of €500 million. Headquartered in Edinburgh, the company now employs over 300 staff worldwide (the majority in Scotland) and sponsors five PhD scholarships per year in the University of Edinburgh.

Gambro hemodialysis

The pioneering work of Prof. Nils Alwall at **Lund University** was the basis for a sustainable and affordable dialysis therapy. The company Gambro was founded to develop and market an artificial kidney, based on Alwall's research. Gambro now has more than 11,000 employees in some 40 countries and in 2005 achieved revenues of \$2.0 billion (US). The business is divided between areas: Gambro Renal Products, Gambro Healthcare and Gambro Blood Component Technology.

Norkom Europe

From early beginnings as a research group at the **Katholieke Universiteit Leuven** focussing on datamining technologies, risk management, customer profiling, advanced data analytics and artificial intelligence, DATA4s spun out of the university and grew to be one of the industry leaders in risk analysis solutions for both the financial services and telecommunications sectors. It has offices in Leuven (Belgium) and London (UK). DATA4s became an incorporated company in January 2000 and in November 2004 was acquired by Norkom Technologies, a consolidation that established Norkom as the leading European provider of Risk Management, Compliance and Financial Crime solutions for the Financial Services sector with a combined client list including many of the top European financial service institutions in a global market for risk management software in the financial services industry worth in excess of €4 billion. The company is valued at €117 million.

Creation of knowledge economy clusters (Box 2)

17. In the current business environment, although innovative solutions to market needs are at a premium, many large companies have moved away from undertaking their own research, but instead scan the global research effort, much in universities, to gain access to the best relevant research. This interaction between universities and knowledge-intensive international companies brings considerable benefit to a region not only through extra funds for research, but also through

awareness of international trends, opportunities for market-led innovation, and in some cases, location of company activities close to the university. Through these processes they may stimulate the creation of major knowledge-based business clusters around them. The universities most likely to play these roles are great research-intensive universities that have a great range of major centres of research excellence at the leading edge and with considerable strength in depth.

Box 2 - Examples of knowledge economy nodes around a university

It involves clustering of knowledge-intensive companies in the vicinity of a university with a powerful, internationally competitive research capacity.

The Cambridge Cluster

The progressive aggregation of high technology companies around the **University of Cambridge** has transformed the economy of its region since 1960. It is Europe's leading technology cluster with a concentration of life science and information technology companies which now numbers around 900 innovation based companies. 51 companies have spun-out directly from the University, a further 250 trace their origins to the University and most of the rest have been attracted by the talents and opportunities available within the growing cluster. The combination of Cambridge's reputation for research and the Cambridge Cluster has attracted global organisations to establish research and development facilities in close proximity to the University. Examples include Genzyme, Intel, Microsoft and Toshiba. This magnetic effect has also attracted major institutions such as Cancer Research UK, the Medical Research Council and the Sanger Centre to the region. A recent report concludes that if the University did not exist, more than £50 billion and over 150,000 jobs would be needed to replace the University's impact on the economy.

The Leiden Life Sciences Cluster

The excellence of the medical and life sciences at the **Leiden University** led to the establishment of the Leiden Bio Science Park in the early 1980s. This has grown into a cluster of the largest concentration of dedicated life sciences companies in the Netherlands. Many of these 40+ companies are involved in R&D and have developed from the Leiden University research base. Others are active in life sciences support services or in manufacturing. The Leiden University Medical College, Science Faculty and Social Sciences Faculty and the Leiden School for Higher Professional Education are located on the Science Park. Over 5,000 people are employed in life sciences research and industry, and another ~6,000 people have employment related to medical care. Incubator buildings support the development and growth of new high-tech companies and the 'Leiden – life meets science' action programme brings together companies, knowledge institutions and the local and regional government to further stimulate cluster growth. The Leiden Bio Science Park has a major impact on the economy of the region.

The Leuven Cluster

Such has been the success of the science park around the **Katholieke Universiteit (KU) Leuven**, with over 150 knowledge-based companies and employing 5,000 people, that a new park has been created in close proximity to the relevant university groups and to the Inter-Institution Micro-Electronic Centre for nanoelectronics and nanotechnology (IMEC), and a third park is being planned. These developments have been the nucleus around which, by 2004, over 300 technological companies had clustered, with a turnover in excess of € 4.5bn and about 15,500 employees. These companies were either spin-offs from KU Leuven or the result of private, mostly foreign investments. Technology clusters have developed in life sciences, food safety, mechatronics, telematics and communication, micro- and nanoelectronics, and e-security. The area has been an important driver of the knowledge economy of Flanders.

Transplantation from elsewhere (Box 3)

18. This involves the relocation of a company's activity because of its manpower needs, regional internal investment policies or increased proximity to important markets. Universities can support this transfer by responding to the company's manpower needs, by developing customised curricula and continuing education programmes, often as parts of a regional

inward investment strategy, whereby the university's willingness to collaborate is important in the decision to re-locate. Further support can come through technical assistance to local suppliers and sub-contractors. This is a role that can be played by major research-intensive institutions, but is frequently associated with regionally-focused universities.

Box 3 – Examples of transplantation from elsewhere

It involves the relocation of a company's activity because of its manpower needs, regional internal investment policies or increased proximity to important markets. Such transplants can develop into the core of a knowledge economy node as in Box 2.

Cadence Design Systems

Several Scottish universities (**Glasgow, Strathclyde, Edinburgh and Heriot Watt Universities**) have an international reputation for excellence in the field of electronic design. To exploit this and in view of the large international market, the regional development agency, Scottish Enterprise, set up the Alba Centre to offer a "quick-start" location for inward-investing microelectronics firms and their design activities. Cadence Design Systems, a US company and one of the world's leading electronic design firms, was attracted to be the first tenant of the Alba Centre because of the relevant research capacity of the universities and their willingness to offer relevant training programmes. Four universities then created the Institute for Systems Level Integration which collaborated with Cadence at the critical interface between the academic and commercial engineering worlds, and in forming the world's first centre of excellence for postgraduate training and research in the methodology and application of system-on-chip design, system level integration and related software and hardware technologies. Subsequently, the Alba Centre's activity has led to a doubling of the size of the electronic design industry in Scotland. The Institute is a unique, collaborative, cross-disciplinary enterprise between university departments of computer science, electronic and electrical engineering and informatics, brought together to focus on the problems of system-on-chip design.

Nokia

Excellence in the Department of Electrical Engineering within **Oulu University** (founded in 1958) in northern Finland, and support from the local authority, persuaded Nokia to locate telecommunications research there. Subcontracting to small firms has stimulated their growth, and collaboration with the university has continued to stimulate innovation, with significant numbers of start-up companies set up by researchers. An important result has been that Oulu reversed the trend of population loss to southern Finland, and started to gain. Similar social effects have been observed elsewhere in isolated areas of Europe such as north Norway (University of Tromsø) and northern Iceland (University of Akureyri). Nokia has also established a major research centre in software development in Hungary because of the excellent teaching provided in Hungarian universities in mathematics and the mathematical research capacities of the universities, which provides them with a source of appropriately skilled personnel. It is an excellent example how industry gains from access to first class university teaching and research, and provides jobs in return.

Sharp Electronics

Sharp Electronics are a world leader in micro-electronic devices. Most of its research was located in Japan until 1990, when the company realised that it needed access to the best consumer electronics research all around the world. Sharp Laboratories of Europe were then founded, which located a major effort in Oxford to be close to the **University of Oxford**. It recruited many world class specialists, created a brand new laboratory complex, and within a short time technology began to flow from the laboratory into Sharp products. The laboratory has been progressively extended and has enjoyed a steady growth.

Diversification into technologically-related businesses (Box 4)

19. Existing business in a region goes into decline, but its core technologies are re-deployed and lead to the emergence of new businesses. A key role for the university is to stimulate technological links between disconnected actors, for example by creating on-campus forums for discussing new applications of existing technological strengths, and helping to build the identity of the new businesses in the region. We believe that this role is not as effectively fulfilled in

Europe as it could be if a larger proportion of universities were to align their strategies and capabilities more closely with regional priorities. We suggest that such alignment is more effectively achieved by regionally-focused universities in the USA. We therefore include a US example in Box 4. It is one of the areas that would benefit from a greater diversification of university roles.

Box 4 – Examples of diversification into technologically-related industries

Existing business in a region goes into decline, but its core technologies are re-deployed and lead to the emergence of new businesses.

Industrial regeneration of North Milan

In response to the closure of the largest factories in the North Milan area in the early 90s, the main universities of the Milan region (**Università degli Studi di Milano, Università di Milano Bicocca, Università Luigi Bocconi**) collaborated with the local development agency, Province of Milan and the Chamber of Commerce in the creation, in 1996, of Milano Metropoli. This was formed to promote the sustainable re-development and socio-economic conversion of North Milan. It has supported the introduction of new technologies, the creation of small and medium enterprises and the reclamation and re-use of brownfield land, and led to the business reinvigoration of the area.

Diversifying in marine aquaculture

The Martin Ryan Institute at the **National University of Ireland**, Galway is involved in a public-private partnership to support an ambitious marine research programme that will build both scientific capability and the physical resources required to support the diversification by the aquaculture sector into the cultivation of new marine finfish species, providing an opportunity to fast-track the development of commercial aquaculture in Ireland. One of the first major steps in building this required capacity in marine finfish R&D will be the establishment of Ireland's first cod hatchery at the Marine Research Institute Carna Laboratories. As an initiative which is funded by the Údarás na Gaeltachta and the Marine Institute and supported by Trouw Ireland Ltd and BIM, the collaborative nature of the project ensures a multidisciplinary input, both from a research and most importantly a commercial viewpoint.

An example from the USA – tyres to advanced polymers

Until the 1980s Akron, Ohio, was the 'tyre capital of the world'. Today not a single tyre is produced there. Yet many of the original companies – or at least parts of them – remain located there and have shifted their emphasis to polymer production. Companies began to invest more in new applications of their core technology, polymer chemistry and engineering. Civic and business leaders saw polymer engineering as a foundation of the city's economic future and called on local universities to take a more active role in supporting innovation efforts in this field. The **University of Akron** initially focused on technology transfer to the large industrial polymer producers, and sought to provide a window on its technology for these firms. Later the university put greater emphasis on entrepreneurship, and on building technical connections among local firms – small, medium and large – that had previously been disconnected from each other. The result has been a rejuvenated industry and highly creative university-business interaction.

Enhancing existing businesses (Box 5)

20. This involves the introduction of new technologies that lead to enhancement of products, processes or services. Such up-grading is particularly important for small and medium-sized enterprises. In this case, the innovation process is customer-driven and influenced by total quality principles and practice, with the anchor institution a lead business or customer. Local universities contribute through contract research and

consulting, bachelors- and masters-level graduates equipped with knowledge of and relevance to the industry's practices and problems during their courses, access to internships, convening foresight exercises and user-supplier forums on campus. These arrangements are most effective where there is a long-term relationship between the university and relevant firms.

Box 5 – Examples of enhancement of existing industries – Old Tech to High Tech

This involves the introduction of new technologies that lead to enhancement of products, processes or services.

Tampere Industrial Machinery

Tampere in Finland was home to a cluster of traditional industrial machinery firms that went into a long period of decline starting in the 1970s, like many similar clusters in Europe and the USA. The recent resurgence of this industry has been based on the infusion of electronic, control, information and communications technologies into traditional machine building, the use of "intelligent" production processes and software-controlled embedded electronic systems capable of controlling machine functions in complex environments. **Tampere University of Technology (TUT)** played a key role as a provider of skilled personnel, technical know-how and relevant problem-solving skills. These contributions have also supported the growth of sub-contractors and parts providers. TUT's role was assisted by the fact that Tampere's leading firms depend on the same set of core technologies, although they compete globally in distinct markets. The readiness of the university to understand and engage with the redevelopment process has been important to its success.

Support for ceramic production in northern Italy

The Centro Ceramico is a university organisation that conducts research on new technologies for tile production and other new products and also provides technical advice and testing services. It is run by a consortium in Emilia-Romagna that includes the **University of Bologna** and the ceramic sector business associations. It has been an important partner for the Italian ceramic industry, to which it offers technical and scientific support for development and for bolstering competitiveness. Further support to the tile-manufacturing cluster of Sassuolo is provided by **University of Modena** which offers a degree course for engineers in ceramic technologies in collaboration with the National Association of Ceramic Tiles Producers.

From eyeglasses to intensive care technology in Helsinki

Over a century ago, a company called Instrumentarium was founded to import eyeglasses and medical instruments. A major departure occurred in the 1970s through collaboration with medical researchers at Helsinki University to exploit a University invention to measure of carbon dioxide in expired air for monitoring patients under anaesthesia and intensive care. During the 1990s the company became a global player in this field and also developed software for handling clinical data and patient documentation. By 2001, Instrumentarium employed 5,400 people worldwide and had annual sales over \$1 billion (US). It was acquired in 2003 by General Electric, which led to the merger of Instrumentarium and GE Healthcare. The company maintains a major research facility in Helsinki, with important collaboration with the **Helsinki University of Technology and the University of Helsinki**.

21. Although the above typology is based on the nature of business transformations, it is evident that there is also a spectrum of university types, from the research-intensive to the regionally-focused, that tend to cover different parts of the transformation spectrum. Moreover we suggest that many other university roles (paragraph 5) can be related to a similar spectrum, from those whose focus is primarily regional to those that are major international research-intensive universities. One of the challenges for Europe is to have universities along this spectrum play to their strengths and thus develop a diversity of function that better matches the need.

Innovation priorities for universities

22. The European Commission's recent communication on the modernisation agenda for universities⁵ recognises their crucial importance for the future of Europe, and correctly identifies many of the structural weaknesses that must be addressed if "renaissance rather than decay" is to be their fate⁴. Although most of the power to reinvigorate them lies in the hands of national governments, the European dimension could also be a source of strength if effectively mobilised. A crucial part of the challenge is to make universities more effective partners for business in stimulating and enabling innovation.

23. The Finnish Presidency of the Commission has emphasised the current primacy of stimulating innovation if the European Union's economic and social priorities are to be met. In response to this, the Commission has proposed "a broad-based innovation strategy for Europe that translates investments in knowledge into innovative products and services"¹⁹ and which sees research and the universities as essential components. The strategy proposes 10 priority actions, many of which involve education and research:

- I. Establish innovation-friendly education systems
- II. Establish a European Institute of Technology
- III. Create a single and attractive labour market for researchers
- IV. Strengthen research-business links
- V. Foster regional innovation through cohesion policy programmes
- VI. Reform R&D and innovation state-aid rules
- VII. Enhance intellectual property rights protection
- VIII. Review copyright levies for digital products and services
- IX. Develop a strategy for innovation friendly lead markets
- X. Stimulate innovation through procurement

24. Whilst many of these initiatives are useful, we suggest to the Commission that it should articulate a simpler, clearer and more direct strategy that concentrates on first order processes likely to have the maximum effect, and avoid small scale, bureaucratic schemes that merely add to the existing complexity of the European research and innovation landscape, but which lack the power to stimulate effective action. We suggest three simple, headline issues that are the key to effective exploitation of the knowledge base in support of innovation. Each has a national and a European dimension. They are:

- **Supply-side structural changes** that improve the capacity of universities to contribute to innovation;
- **Demand-side incentives** for the exploitation of the knowledge base;
- **Improving processes of interaction** between universities and industry.

The supply side – enhancing the capacity of university systems

25. As a generalisation, and there are national exceptions in each case, key areas that require structural reform in European universities are in autonomy, diversity, cross-disciplinary capacity and funding.

Autonomy

26. Universities that are perceived as beacons of international research, scholastic and innovative excellence and effectiveness have complete or considerable autonomy from the state. This permits them rapidly to re-shape their research efforts, their teaching programmes, their contributions to innovation and their employment policies without perennially seeking governmental approval or political sanction for detailed processes and itemised budgets, as occurs in many European university systems. Without autonomy, university systems are unlikely to realise their potential for their societies. Governments should set broad strategic priorities and require accountability for quality, efficiency and research and teaching targets, but leave the processes of governance, organisation and direction to the institutions. Energetic, responsive and autonomous institutions also need good leadership (paragraph 7), and many may need to review their procedures for selecting university leaders. At the same time, accountability, sensitivity to the expectations of stakeholders and the need for external expertise and advice require that the governing bodies of universities include external members.

19. European Commission. 2006. *Putting knowledge into practice: a broad-based innovation strategy for the EU*. COM (2006) 502.

Diversity

27. If a university system is to contribute effectively to the transformation processes set out in paragraphs 15-20 it must comprise a spectrum of institutions, from those competing at the leading edge of the international research agenda and offering education through awareness of the frontiers of human understanding, to those most deeply engaged with their local communities in satisfying the local demand for graduate skills, training programmes and market-driven consultancy and advice.
28. In recent decades, there has been a convergence of roles amongst European institutions as more have acquired the title “university”. For example, in the UK, although the 4-6 yearly Research Assessment Exercise (RAE) has had a major beneficial impact on the excellence and international competitiveness of UK university research, the criterion of excellence in basic research has in practice dominated RAE assessments, to which most universities have responded by focusing their efforts in this domain. The consequence is that the spectrum of research and research-related activity amongst them has been narrower and less diverse than is desirable, with a relative lack of differentiated purpose, structure and mission. At the same time, a relatively small proportion of institutions capture the lion’s share of funding, with the consequence that a large number of institutions receive very little RAE-based funding, although they still permit their research profile to be driven by the RAE criteria. Across Europe, at least 980 universities propose, in their mission statements, to achieve a high level of international excellence in research²⁰. This reflects both an unrealisable aspiration and a lost potential for many other areas where universities can bring benefit to their local communities.
29. It is crucial to recognise the need for diversity and develop processes that stimulate it. We suggest that this is best done through separate but competitive funding streams that permit some universities to compete at the highest international levels of excellence and others to concentrate on a more explicit regional role, responding more clearly to regional economic, social and cultural needs and playing a key role in regional strategies. Competition for funding is essential as a means whereby new centres of excellence can develop at the expense of established ones that have lost their edge. It is only by enhancing the inter-

nal competitive environment that European universities will compete with the best globally. We must move away from an approach that sees a hierarchy of excellence in a spectrum of university roles towards one of that recognises a diversity of excellence.

Cross-disciplinarity

30. Public and private needs for research, by business or others, and many of the great fundamental research challenges, increasingly demand cross-disciplinary collaboration. The classical, broadly-based research intensive universities, with their unrivalled breadth of research capability, are not only uniquely placed to exploit new cross-disciplinary challenges in basic research, but also uniquely placed to respond to business demands for solutions in inherently cross-disciplinary areas such as energy, materials and public policy. Many have been highly creative in doing so, with imaginative and productive re-configurations of their diverse research efforts. Much remains to be done however. Change requires effective and professional university leadership able to stimulate and manage greater dynamism, the autonomy rapidly and flexibly to promote and implement change, patterns of research funding that do not discriminate against cross-disciplinarity, and the capacity to create and exploit networks of institutions. At a European level, the European Technology Platforms could become valuable means of articulating major cross-disciplinary research needs and stimulating a response from the research community.

Funding levels

31. In a world in which research and higher education are vital contributors to economic success, European levels of investment in them are inadequate by any standard. In a Europe of taxation-averse governments, it is difficult to see where investment can come from unless through the highly contentious route of tuition fees. Otherwise, we simply need to make smarter investments of existing public funds. The spectrum of roles in paragraphs 15-20 suggests such an approach. At one end, where internationally competitive excellence in basic research is vital, about 2,000 universities in the EU aspire to an important research role, compared with US in which about 100 research-intensive universities compete for a similar level of total funding. We need to ensure that funding follows high levels of international excellence by making research funding systems more competitive across Europe. We hope that the European Research Council will evolve into a body that can play

20. Statement from the European Commission’s Education Directorate General. Dean Conference, Edinburgh, September 2006.

a fundamental role in doing this. At the other end of the spectrum, universities that are more strongly engaged with their regions in responding to their research and skills needs, are much more likely to attract investment from local industry and regional development bodies than universities that are competing unsuccessfully in basic research and whose activities seem poorly coupled to regional needs.

Stimulating demand

32. We have stressed (paragraph 3b) the vital need to stimulate demand for the research-based capacities of the universities. In part this can be done when universities are aware of the role that they are able to play in their regions through the processes listed in 15-20. However, this is likely to be a slow process as Europe starts from a weak position of low business investment in R&D²¹. In this vital part of the innovation equation, we must create mechanisms that have real power to change behaviour. We believe that such a mechanism could be the power of public procurement as an incentive for business to exploit the research and knowledge base represented by universities. A weak version of this is numbered 10 amongst the actions recently proposed by the Commission (paragraph 23). It should be greatly strengthened and promoted to action number 1.
33. The World Trade Organisation rules that forbid discrimination against foreign goods do not apply to pre-competitive procurement, which most clearly applies to R&D procurement. In 2004, governments across Europe spent in excess of €170 billion per year on public procurement²² including about €1.64 billion procuring the research and development they needed. It is imperative that this buying power is used as a major driver for innovation. Currently, and broadly speaking, this only happens in defence, which of necessity must procure for future capacity. Otherwise, governmental procurement in Europe tends to be risk-averse, and governments are late adopters of new technology. The *value for money* criterion tends to be interpreted as *lowest cost now* rather than *best value in the long term*. Normal procurement processes tend to select well-trying, low cost technologies from major suppliers, which militate against novel technologies, small and medium enterprises (SMEs), and ignore and fail to include in their accounting the role that procurement could play in stimulating innovation. This could give companies an incentive to enhance their demands on the research base, increasing R&D investment and supporting the growth of SMEs.
34. The growth of knowledge-intensive start-up companies and small and medium enterprises is crucial to Europe's economic future (paragraph 2). It is sometimes said that their growth is dependent upon early availability of investment finance. We take the view that although this is important, investment finance is in principle not in short supply. It is the early availability of contracts for products and services that is more crucial and the determinant of early growth, where a company's products or services can be market tested and adapted and diversified to demand. Such a demand environment is also one that minimises the rate of early company failure.
35. If governments across Europe were to develop processes for using a proportion of their R&D procurement budgets to stimulate, through purchase-contracts rather than grants, the development of tomorrow's technology, it would boost the early growth rate of knowledge-intensive companies, reduce the rate of company failure, encourage them to draw on the research base, enhance interaction between companies and universities, stimulate investment in the knowledge sector by increasing the potential profitability of SMEs, and be a vital tool in Europe's efforts to compete with the increasingly technologically sophisticated, but still low wage economies of China and India. It is difficult to see how the Lisbon agenda target of 3% of GDP invested in research can be reached unless this mechanism is effectively exploited. Since SMEs account for ca. 80% of employment, their role is also crucial for the growth and jobs that are main targets of the renewed Lisbon agenda.
36. The maintenance of high US growth rates in the last two decades, when Europe's growth rate has fallen far behind those of developing Asian economies, may in part be due to its Small Business Investment Research Programme (SBIRP) (Box 6)²³. This offers procurement contracts for the development of technologies that US federal government agencies believe they require as customers, specifiers or research organisations²⁴ and

21. However, the increasing role of the service sectors in the economy is not captured by the Frascati definitions through which R&D expenditure is normally assessed. There is an urgent need to revise the methods by which R&D expenditure is reported.

22. Work Group on Public Procurement. 2006. *Pre-Commercial Procurement of Innovation*. European Commission.

23. Connell, D. 2006. "*Secrets*" of the world's largest seed capital fund. Centre for Business Research, University of Cambridge.

24. Autio, E., Bianchi-Streit, M. and Hameri, A-P. 2003. *Technology transfer and technological learning through CERN's procurement activity*. CERN, Geneva.

produces precisely the benefits described in the preceding paragraph. Because of the demand that it creates for tomorrow's, rather than yesterday's, technology, it has converted billions of dollars of US taxpayer-funded research into high value goods and services, stimulated the growth of many knowledge-intensive companies, helped thousands of academics to become entrepreneurs, and created a dynamic, highly interactive environment between business and universities that has stimulated innovation. Because of the need of companies that benefit from the SBIRP to employ and have access to skilled researchers, it is an environment where PhD graduates are more highly prized than in Europe as a vital link between the new

knowledge created in the research base and its application in business²². Current EU-wide R&D procurement is highly inefficient in comparison with its US counterpart as a driver of high value business growth (Box 6). We strongly advocate that a scheme analogous to that of the US should be adopted by EU member states, and support parallel recommendations in recent European reports ^{9,25}.

37. Unfortunately, whereas the US expends 15% of its total procurement budget on R&D, Europe only expends less than 1%. We believe that the power of the public procurement mechanism for stimulating business growth is such that this alone would justify a

Box 6 – The potential of public procurement as a driver of innovation

The US Small Business Innovation Research (SBIR) Programme ²³

While World Trade Organisation rules forbid discrimination against foreign goods, this does not apply to pre-competitive government procurement. That it most clearly applies to procurement of R&D has been used by the US government as a powerful driver of innovation and small business growth. In 2004, the US Government spent about 15% of the total federal procurement budget of over \$735 billion on R&D. Federal legislation requires all larger Federal Government Agencies to set aside 2.5% of this annual external R&D procurement budget (about \$49 billion in 2004) to be spent with small businesses. A small Business Technology Transfer Programme has also been created to support similar projects in collaboration with universities with a set-aside of 0.3%. Each year over 4,000 contracts are placed with a value in excess of \$2 billion. The contracts are placed for products and services for the development of technologies that the agencies believe they will require. The requirements are specified in regular, fixed-date solicitations, and contracts tend to favour forward-looking technological proposals. They therefore tend to stimulate a research culture, links with the research base and employment of research-skilled doctoral graduates. The aim is that such contracts will lead on to mainstream development contracts or subsequent procurement of developed products. The successful business owns the IP, companies do not have to be formed until contracts have been won, contracts are 100%-funded plus a profit element and there are no state or regional quotas. Over a ten year period, SBIR-funded companies generated five times as many jobs as new non-SBIR funded firms, and over 300 SBIR contract winners have public market listings. The programme has played a major role in the dynamism of the US knowledge-based economy.

The contrast with European procurement ²⁵

In developed economies, public procurement accounts for 15-20% of GDP. The proportion of this allocated to R&D procurement in Europe could in principal be used as a driver of innovation in Europe as it is in the US. Unfortunately, in 2004, European Union-wide R&D procurement was less than 1% of the total procurement budget, amounting to some €1.64 billion. Although the biggest part of this difference is due to lower EU defence spending compared to US defence and space spending, the civilian sector is also four times less than in the US case. We draw two conclusions: even the much lower R&D procurement in European national budgets should be used for systematic procurement of forward-looking technologies to create a growth effect analogous to that in the USA; a larger proportion of the European procurement budget should be allocated to R&D.

25. European Commission. 2006. *Creating an innovative Europe*. Report of the Independent Expert Group chaired by Mr. Esko Aho.

substantial increase in the proportion of procurement budgets allocated to R&D.

38. PhD graduates are one of the most important links between the university research base and knowledge-intensive companies. They are aware of leading edge concepts in their field, they bring knowledge of the laboratories that they have recently left, and are ideal links between their company's market interests and the capabilities of the university research base. They are often crucial agents in the innovation system. However, whilst many of the interactions described in Box 7 involve movement of students between a university and company, it remains the case that over 80% of US PhD graduates work in industry compared with 50% in Europe. We suggest that this situation will not change significantly unless the competitive advantage of hiring PhD graduates is more obvious to potential employers. We suggest that a powerful public procurement programme along the lines of the US SBIRP would have this invaluable side-effect.
39. Other measures that have the potential to increase demand on the research base include tax reduction schemes for R&D and innovation expenditures, and direct financial support for specific projects²⁶.

Stimulating business-university interaction

40. In a European environment in which the self-interest of business does not lead it to pull on the knowledge base as strongly as in the USA, it is vital that iterative interactions between business and universities are stimulated. Whilst paragraphs 15-20 attempt to summarise the business transformation processes in which universities typically become involved, all of them require strong business-university interaction. The challenge and opportunity for business [this is particularly true in the service sector] is to upgrade the business model through combinations of product design, service, system and distribution improvements. There is rarely a "eureka" moment when a dramatically novel concept suddenly enhances the business opportunity. Bringing perspectives and knowledge pools together interactively and iteratively creates the concept and the practical opportunity for innovative advance. Many universities, businesses and several national governments have been highly creative in developing schemes designed to enhance these interactions, some of which are summarised in Box 7. We stress however that the business demand for research and enthusiasm for interaction is unlikely to increase as
- a consequence of governmental exhortation. Demand stimulation through incentives such as those described in paragraphs 32-39 are crucial.
41. Processes such as those in Box 7 attempt to improve the effectiveness of knowledge exchange activities between the business and universities through incentives and improved effectiveness of interface-spanning mechanisms and institutions. They particularly concentrate on the many market failures and shortfalls in competence that limit the interaction of the supply and demand sides of the innovation process:
- There is a lack of skill and competence at the collaboration interface (the 'interface-spanning' function), this includes technology transfer and knowledge exchange specialists.
 - There is often a failure to recognise that informal knowledge exchange processes (networks, interactions, graduating students) are frequently the most effective means of knowledge exchange between universities and business. These informal mechanisms must be supported by formal mechanisms such as patents, licensing and publishing.
 - The incentive structures in universities are different to those of business and this can hamper the knowledge exchange process. Processes that facilitate greater personnel exchange in both directions are needed.
 - Time frames are different. Business generally seeks quicker, commercially effective results compared to universities.
42. Given the diversity of national and regional economies and business sectors, we are sceptical that the Commission could be an effective agent in promoting or funding such schemes, and that they are best left to national and regional agencies, although European structural funds could be important in helping develop some countries' systems and the Commission could be an agent for the circulation of good ideas and best practice. In addition, all should strive to reduce bureaucratic complexity and remove administrative barriers that often complicate industry-academia relationships²⁶.
43. The current European Commission proposals for a European Institute of Technology (EIT) (Communication 13.9.06) focus on improving "Europe's innovation capacity and performance" through networked consortia working in the "knowl-

26. *Innobarometer Europe*, 2006.

Box 7 – Examples of industry – university interaction processes

Rolls Royce Aerospace is one of the world's top three manufacturers of aero engines, and depends upon access to the best innovative science and skills to ensure its continuing competitiveness in a fiercely high-tech market. It maintains this access through its University Technology Centres, of which there are 25 worldwide (15 in the UK, with others in Germany and Italy). The UTCs provide two-way benefit, giving the company access to the best talents and emerging science and technology, and the universities with real-life challenges in some of the highest-technology industry sectors as well as long-term collaboration and funding.

Université Pierre et Marie Curie, Paris, has an incubator called Agoranov that specialises in the coaching of high-tech start-ups and has rapidly become a major player in new business creation in Paris where it is stimulating the local economy with the creation of over 60 new businesses, generating nearly 300 jobs, half of which are in R&D.

Matheon - a collaboration between Freie Universität Berlin, Humboldt University, and TU Berlin and two mathematical research institutes in Berlin - raises the profile of mathematics research and focuses its application to the life sciences, traffic and communication networks, production, electronic circuits and optical technologies, finance and visualisation. It links industry and researchers through its 'MathInnovates' portal.

The University of Heidelberg Catalysis Research Laboratory (CaRLa), a research alliance with BASF, is an example of the University's "Industry on Campus" Concept. It is a strategic research cooperation allowing six university researchers and six BASF scientists to work together in the same rooms on basic as well as on industry-driven research, and involving technology transfer with a strong publication and IPR policy.

The University of Geneva nurtures young "entrepreneurs to be" by providing undergraduates and young researchers with training in intellectual property law and business planning and providing a venue for chief executives of existing start-ups to meet would be entrepreneurs through the Lake Geneva Innovation Society.

The Leeuwenhoek Starters Project is a public-private partnership for company creation led by Leiden University which supports the creation of high-tech companies from the Leiden research base by providing support for scouting and screening of technologies, for patenting inventions, facility sharing and business coaching.

The Conectus network, a "cross-platform" initiative involving the four Alsatian universities, the local representatives of national research organisations (CNRS and INSERM), two independent engineering schools and the University Hospital, provides an interface between industry and academic research – a "one stop shop" for innovation that directs industry approaches to the relevant institutions.

The Knowledge Integration Community (KIC) concept was developed by the Cambridge-MIT Institute. They combine *education*, *research* and *knowledge exchange* through the formation of a collection of participants including academics, industry, government and not-for-profit organisations. The fundamental premise is that activities are synergistic and that sector or problem-based communities challenge universities to deploy their intellectual resources in new ways. A KIC can be the source of a Masters programme with direct business relevance and participation. Because the KIC is created around emerging knowledge and perceived sector problems, the programme is likely to produce innovation-aware and entrepreneurial students.

Stockholm/Uppsala is one of the world's strongest neurotechnology clusters. It includes several outstanding research groups in the Karolinska Institutet, the Royal Institute of Technology, and Uppsala University and several small R&D intensive companies as well as the multi-national, AstraZeneca. Karolinska Institutet Innovations has been a key player both in terms of spin off companies and in focused efforts to promote research within the region. The location of OECD's neuroinformatics international coordinating facility in Stockholm provides further international links.

edge triangle” of research-education-business, in technology areas to be specified by a Governing Board. The President of the European Commission has recently commented (October 2006) that “the EIT will tear down the walls between research, education and business, to unlock Europe’s potential for innovation”. These walls have long since been broken down and, as exemplified in this document, active engagement in the “knowledge triangle” is widespread. The EIT is yet another supply-side initiative that will simply add to existing activities. Although it will no doubt add a further quotient of benefit, it is not the behaviour-changing “big-bang” that Europe needs to face its current challenges, which would be much better served through the demand-stimulation processes advocated in this document. We remain critical^{9,27} of its “top-down” approach, the Commission’s failure to interrogate or learn from the experience of universities and businesses in Europe involved in the “knowledge triangle”, its potential to undermine the hard won achievements of European universities in the international league of excellence and the threat it poses to the growth potential of the European Research Council. In creating the EIT, we suggest that the Commission heeds the lessons for university-business engagement with innovation that have been learned, and that are described in this document, and consults with and appoints to the Governing Board those in universities and business with practical experience of the optimal function of the “knowledge triangle”.

Comments on the Commission’s “Broad-based Innovation Strategy”¹⁹

44. We welcome the Commission’s communication, but in view of the foregoing discussion would suggest that the strategy’s headlines in so far as they refer to the universities should be **supply, demand** and **interaction**. It is important to distinguish those actions (see paragraph 24) which are first order drivers of behaviour that will create a strong response, from those that are behavioural responses to the driver and are unlikely to be realised by persuasion alone, from those that are useful enabling actions. We regard procurement (x) [with (vi) as a valuable corollary] as a first order, demand-side driver of behaviour, which would stimulate interactions such as those in (i) and (iv). (iii) would be a valuable supply-side development, and (vii) and (viii) would be useful enabling mechanisms. We have argued before^{9, 27} that the EIT (ii) as presently conceived is misconceived. We are also sceptical about action (ix) (paragraph 23) as currently described.

27. League of European Research Universities (LERU). 2006. *Purpose, structure and functions of a European Institute of Technology: commentary*. Position paper 5.

Recommendations

45. Actions are required at member state, European Union and university levels in three principal areas: in improving the supply-side attributes of universities that optimise their contribution to innovation; in stimulating business demand for university engagement; and in improving the processes of interaction between universities and business. These should be the headline issues for the European Commission in their *Broad-based innovation strategy for the EU*.

In improving the quality and appropriateness of supply

46. Member states should, where appropriate:

- increase the autonomy of institutions in ways that will permit them to act in a more flexible and dynamic fashion, but which retain accountability for the use of public funds;
- recognise the vital need for appropriate diversity in their higher education systems and encourage its development through appropriate funding mechanisms;
- seek to enhance inter-disciplinary research through prioritisation in research funding processes and programmes designed to address major technological issues likely to be of major importance to industry;
- set up processes to more effectively harness the research base in support of the fast growing service industries;
- seriously address the issue of university funding in a vital area of the modern economy, either through additional state or personal revenue or/and through the mechanisms of local engagement described in paragraph 31.

47. The European Commission should:

- encourage member states to pursue the above objectives, and those summarised in the Commission's "Modernisation Agenda for Universities";
- encourage cross-disciplinary research through the Framework Programmes and by using the European Technology Platforms as means of driving part of the cross-disciplinary research agenda;
- improve integration between DG Enterprise and DG Research in bridging the gap between basic research and market-oriented pilot projects.

48. Individual Universities should:

- realistically analyse where their own strengths lie and where they might best achieve excellence and economic and social relevance;
- understand, engage and promote the optimal economic strategy for their region, and understand how their own particular strengths can best be mobilised to support regional and national economic development;
- ensure that academic and departmental structures and their flexibility enhance and do not impede cross-disciplinary efforts;
- ensure that their processes of selecting university leaders and governance mechanisms are well designed to identify and pursue broad institutional goals in their areas of strength whilst encouraging the academic freedom that is the university's greatest potential strength.

In stimulating business demand for skills and research/knowledge

49. Member states should:

- implement processes through which the power of their public procurement budget could be harnessed to create strong incentives to draw more strongly on the university skills and knowledge base as a means of stimulating high value technological growth, the rapid growth of SMEs and the effectiveness of interactions between universities and business;
- increase the proportion of their procurement budgets allocated to R&D in order to maximise the impact of this growth mechanism;
- increase the strength of tax incentives for R&D;
- ensure that national regulations are not designed to favour perpetuation of old technologies to the detriment of the novel, whilst ensuring that public confidence in regulation is maintained.

50. The European Commission should:

- make the issue of public procurement the first order issue in its innovation strategy, and ensure that state aid rules do not conflict with this overriding priority;
- continue to press that the market for research and researchers should be Europe-wide, so that the scale of the European market can be more effectively mobilised for Europe's economic advantage, rather than limiting the market effect to the scale of individual national markets;
- ensure that EU regulations are not designed to favour perpetuation of old technologies to the detriment of the novel, whilst ensuring that public confidence in regulation is maintained.

In improving interactions between universities and business

51. Member states (& their regional bodies) should:

- continue to explore and fund, in association with business, processes that enhance interaction between universities and business that are relevant to the operation and structure of their economies, and that address some of the limitations identified in paragraph 41.

52. The European Commission should:

- recognise that interaction processes are often so nationally, regionally and sectorally specific that the principle of subsidiarity should apply. Initiatives such as the Technology Platforms and Joint Technology Initiatives can provide a helpful framework for interaction in particular technology and business sectors that exploit the scale of the EU, and the Commission could help by ensuring that good ideas and good practice are disseminated, but it should not seek to design and manage small scale interventions of dubious utility;
- recognise the considerable advances made by business and universities in this domain, and develop its current EIT concept to:
 - a) learn the lessons about university-business engagement with the innovation process summarised in this document;
 - b) consult with those in universities and businesses with practical experience of the operation of the “knowledge triangle” in the innovation process;
 - c) and appoint such people to the Governing Board of the EIT.

53. Universities should:

- Continue to develop interaction processes in collaboration with business, and in particular to create processes that recognise their potential in business transformation processes (paragraphs 15-20) in relation to their particular strengths.

LERU

Working Group on EU Research Policy

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